

# Microrredes Eléctricas



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# 1

# Electrical Microgrids

1. Introduction.
2. Course's Program Review.
3. The Microgrid Concept.



# 1. Introduction

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# 1. Lecturer and Students Introduction



# 1. Introduction

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Instructor: Nelson Leonardo Díaz Aldana, Universidad Distrital Francisco José de Caldas, Bogotá, Colombia.

- Electronic Engineer (Universida Distrital Francisco José de Caldas).
- Magister in Industrial Automation (Universidad Nacional de Colombia).
- Ph.D in Energy technology (Aalborg university, Major in Microgrids).
- Associate profesor in Power Electronics and Microgrids at Universidad Distrital Francisco José de Caldas.

Currently, I am leading the Research Laboratory in Renewable Energy Sources at Universidad Distrital. My research interests include grid integration through power converters, microgrid control, and management.



# Metodology.

- Main concepts will be introduced by oral presentation.
- Simulation models will be used to verify the operation of each stage in the grid connected PV system.
- Experimental validation will complement the understanding of concepts.

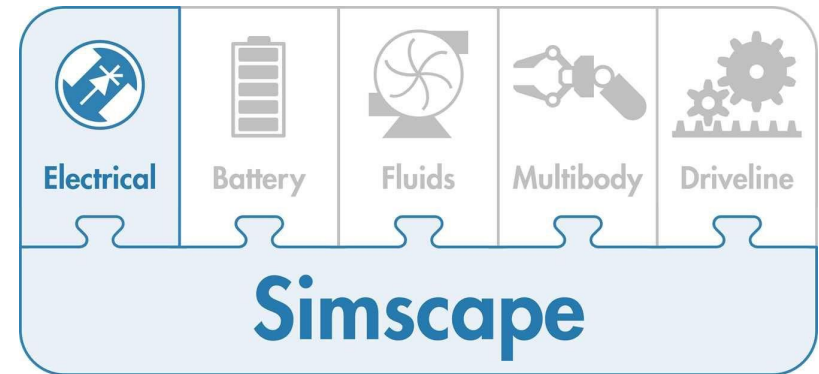


# 1. Introduction

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## Resources.

- Software.



- Models were built in MATLAB/Simulink. Version 2020b and newer can be used.

**HOMER** Software



# 1. Introduction

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## Resources.

- Technical Papers.



ScienceDirect®

**IEEE Xplore**®

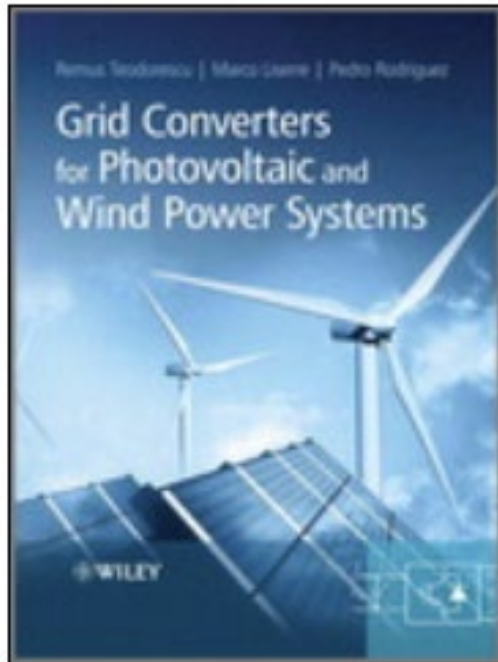


# 1. Introduction

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## Resources.

- Books.





# Resources.

- Technical Regulation and Standards.
  - *IEEE 1547-2011 Interconnection of Distributed Generation.*
  - *IEEE Power and Energy Society, IEEE Standard 2030.7, for the Specification of Microgrid Controllers. 2017.*

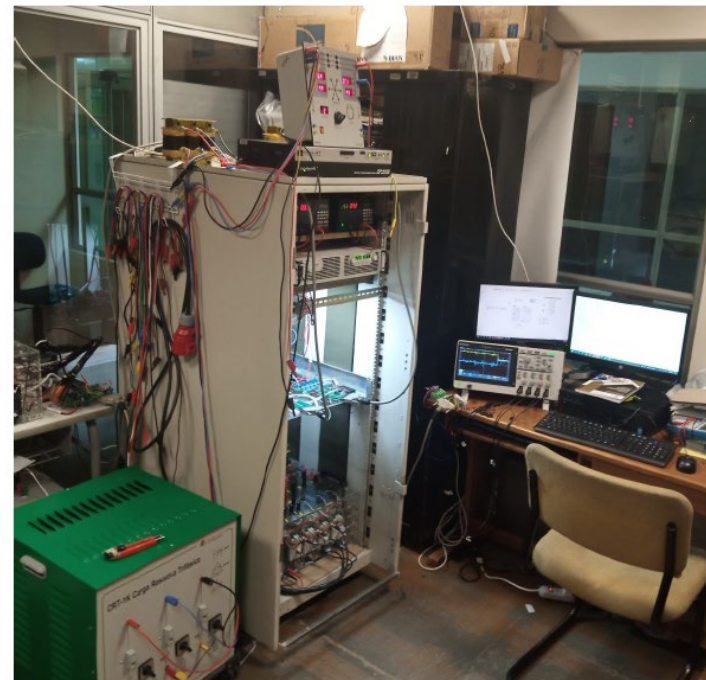
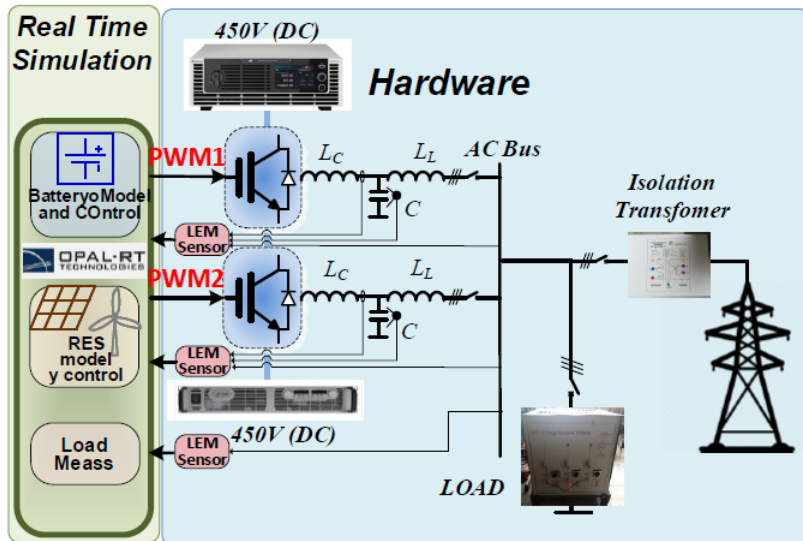


# 1. Introduction

## Resources.

- Microgrid Research Laboratory.

### AC Platform

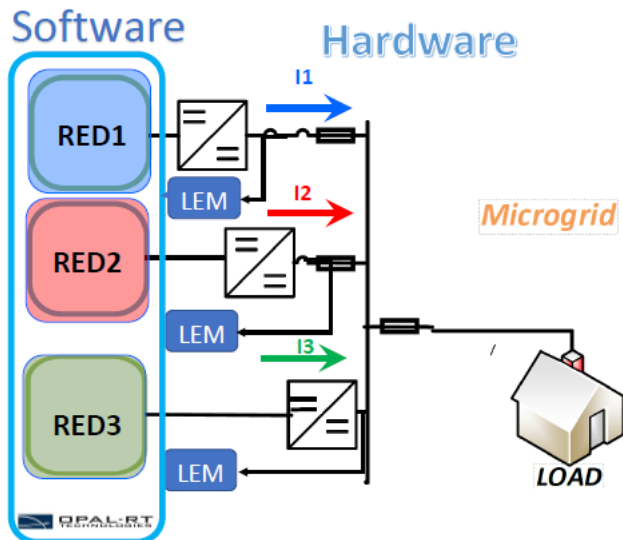


# 1. Introduction

## Resources.

- Microgrid Research Laboratory.

### DC Platform



[LIFAE 1.mp4](#)



## 2. Course's Program Review.

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# 2. Course's Program Review.



## 2. Course's Program Review.

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### Program

- Introduction to Microgrids
- Microgrid's Classification.
- Hierarchical Control.
- Secondary and Tertiary Control.
- Coordination and Management for Microgrids.
- [Syllabus](#)



### 3. The Microgrid Concept.

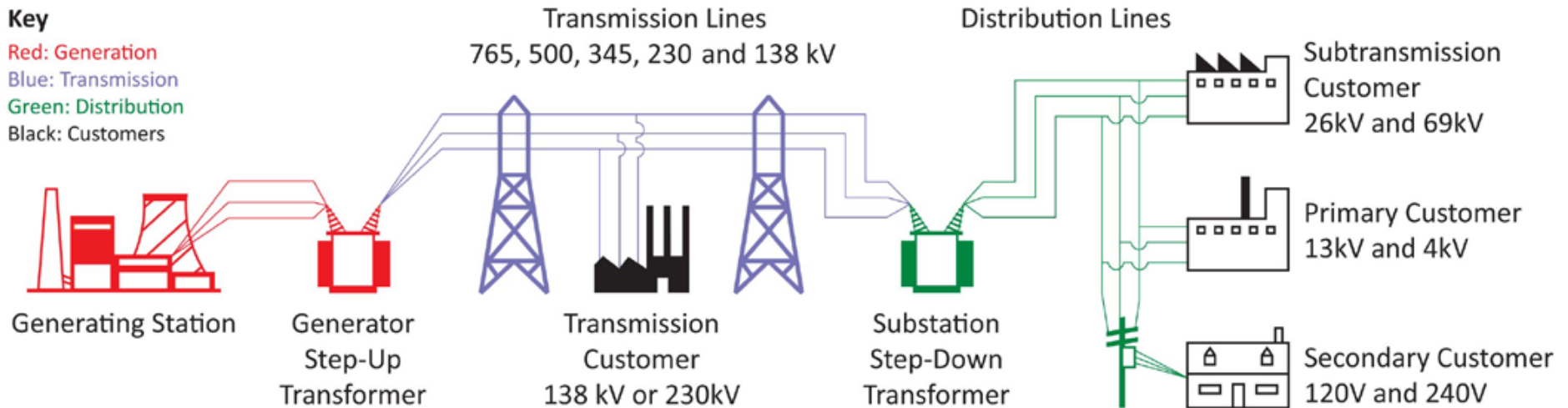
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# 1. The Microgrid Concept.



### 3. The Microgrid Concept.

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(Source: Understanding the Grid)





### 3. The Microgrid Concept.

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# Conventional Generation





### 3. The Microgrid Concept.

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# Transformer at a power plant



### 3. The Microgrid Concept.

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# Switchyard



### 3. The Microgrid Concept.

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#### Transmission lines



### 3. The Microgrid Concept.

# Substation



[https://www.osha.gov/SLTC/etools/electric\\_power/illustrated\\_glossary/substation.html](https://www.osha.gov/SLTC/etools/electric_power/illustrated_glossary/substation.html)

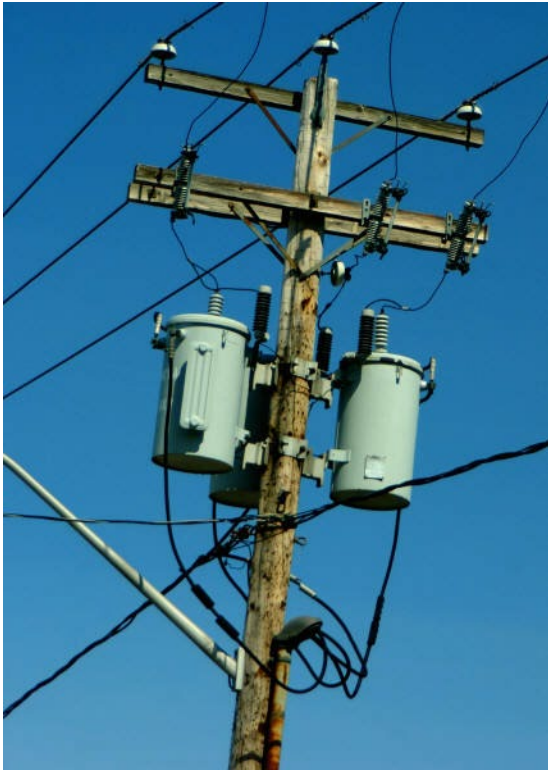




### 3. The Microgrid Concept.

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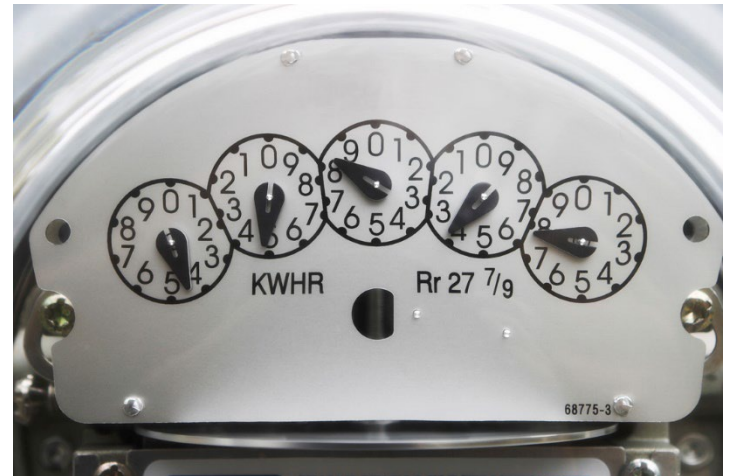
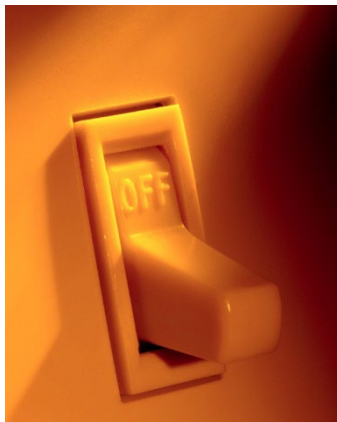
# Distribution



### 3. The Microgrid Concept.

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## Users



### 3. The Microgrid Concept.

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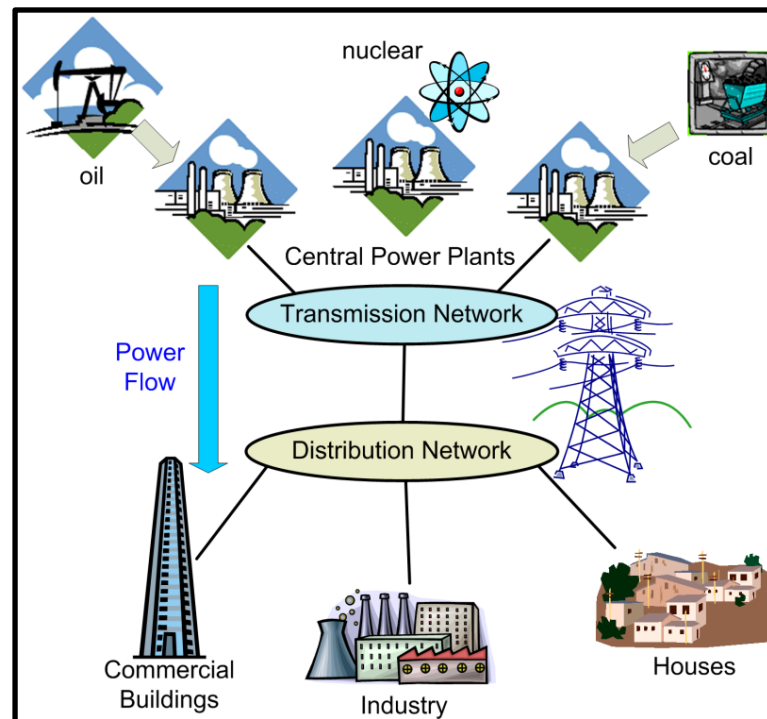
#### Conventional Power Systems:

Characteristics:

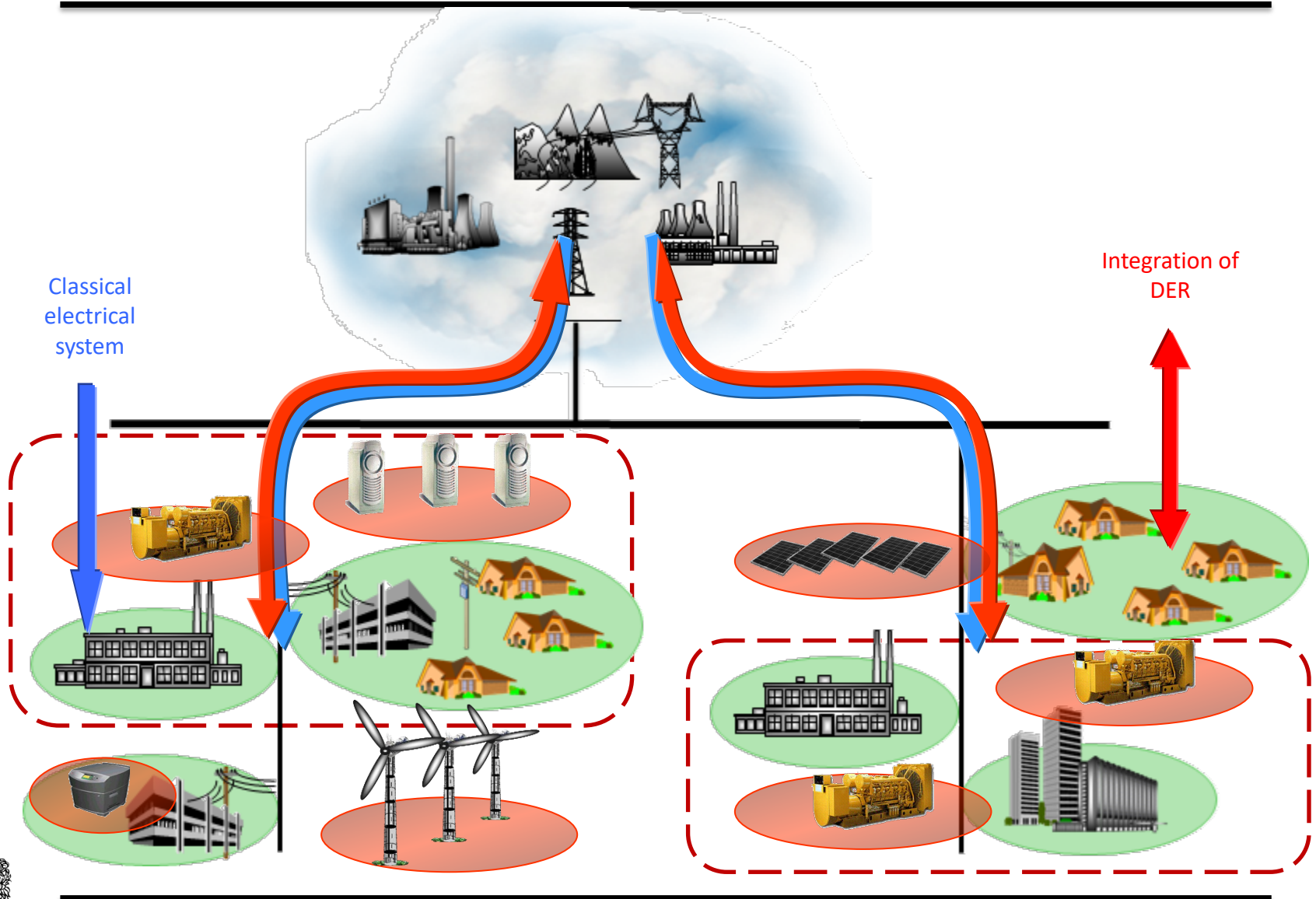
- Centralized Systems
- Unidirectional power flow

Issues:

- Environmental Impacts
- Reliability and resilience



### 3. The Microgrid Concept.



### Power System: Microgrids

Associate Professor: Fabio Andrade, PhD





### 3. The Microgrid Concept.

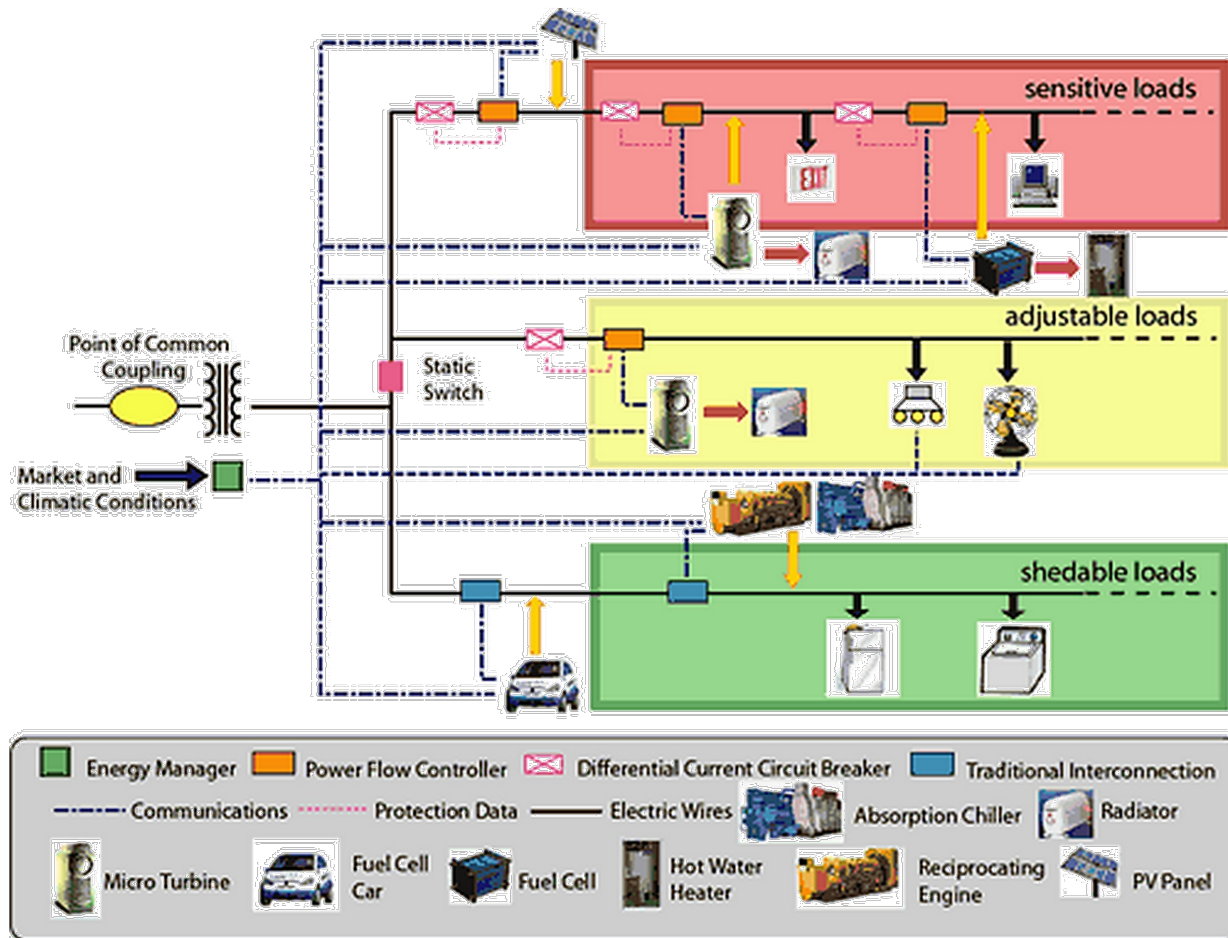
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*“... MicroGrid concept assumes an **aggregation of loads and microsources** operating as a **single system providing both power and heat**. The majority of the microsources must be **power electronic** based to provide the required flexibility to insure operation as a single aggregated system This control flexibility allows the CERTS MicroGrid to present itself to the bulk power system as a **single controlled** unit that **meets local needs for reliability and security**.” [Lasseter et al, 2002]*

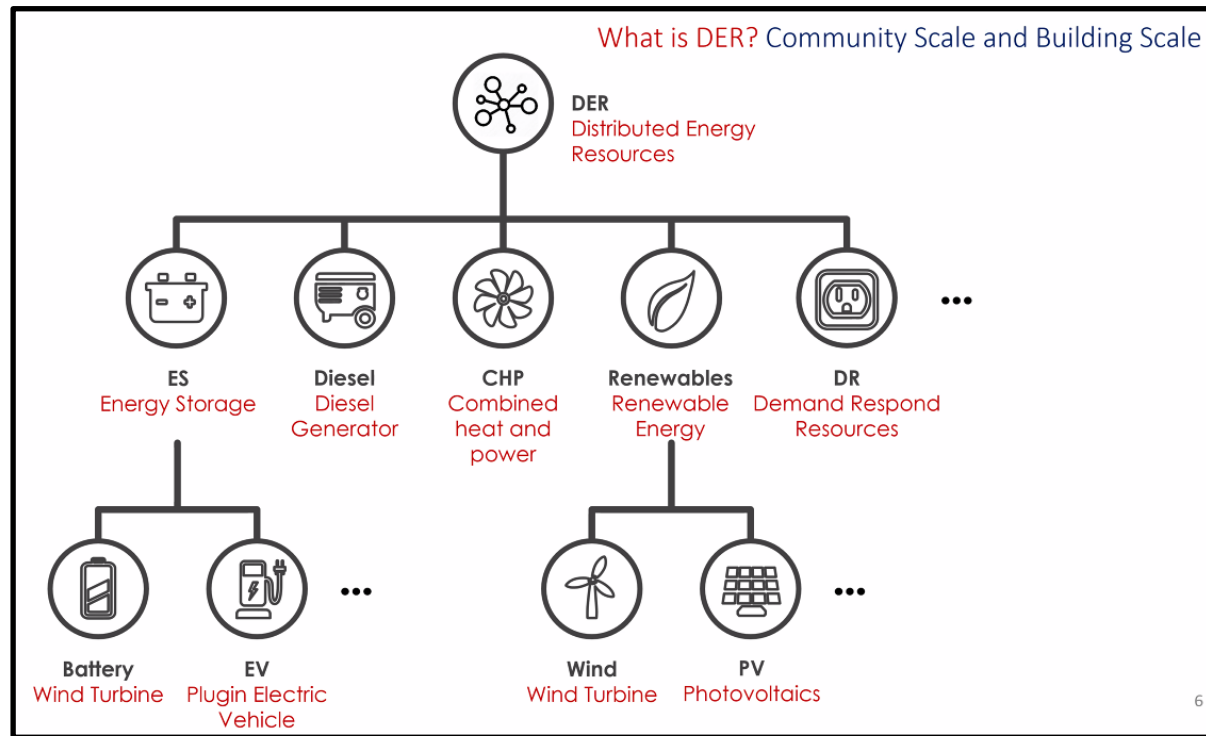


### 3. The Microgrid Concept.

**Microgrid proposed by the CERTS (Consortium for Electric Reliability Technology Solutions)**



# 3. The Microgrid Concept.



# 3. The Microgrid Concept.

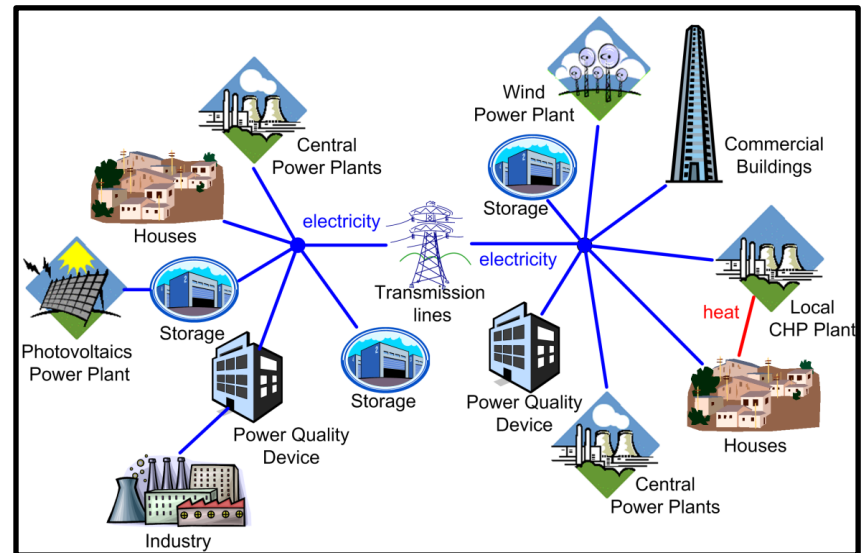
## Current Power System Paradigm

Characteristics:

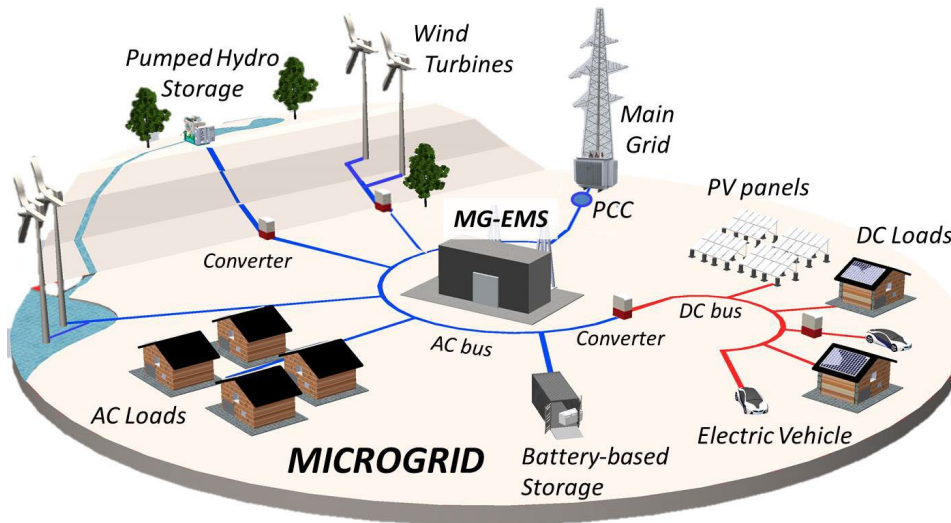
- DERs-based decentralized systems.
- Bi-directional power flow
- Diverse kinds of interconnected energy

Challenges:

- Controllability of heterogeneous distributed devices. Power electronics.
- Observability of events
- Consumers become prosumers
- Regulation



### 3. The Microgrid Concept.



IEEE 1547<sup>1</sup> - Microgrids (MGs) are Electrical Power Systems (EPSs) that :

1. Integrate Distributed Energy Resources (DER) and loads
2. Can be disconnected from the area EPS
3. Contain the local EPS
4. Intentionally planned

Low/medium voltage grids "(...) aggregating and managing largely autonomously their own supply- and demand-side resources"<sup>1</sup>

<sup>1</sup> IEEE 1547 Series Standards - 1547.4 - 2011 Guide for Design, Operation, and Integration of DR Island Systems with EPS  
<sup>2</sup> CEN CENELEC ETSI Smart Grid Coordination Group, "SGCG-M490-G Smart Grid Set of Standards Version 3.1", Technical report.



### 3. The Microgrid Concept.

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# Microgrid Examples

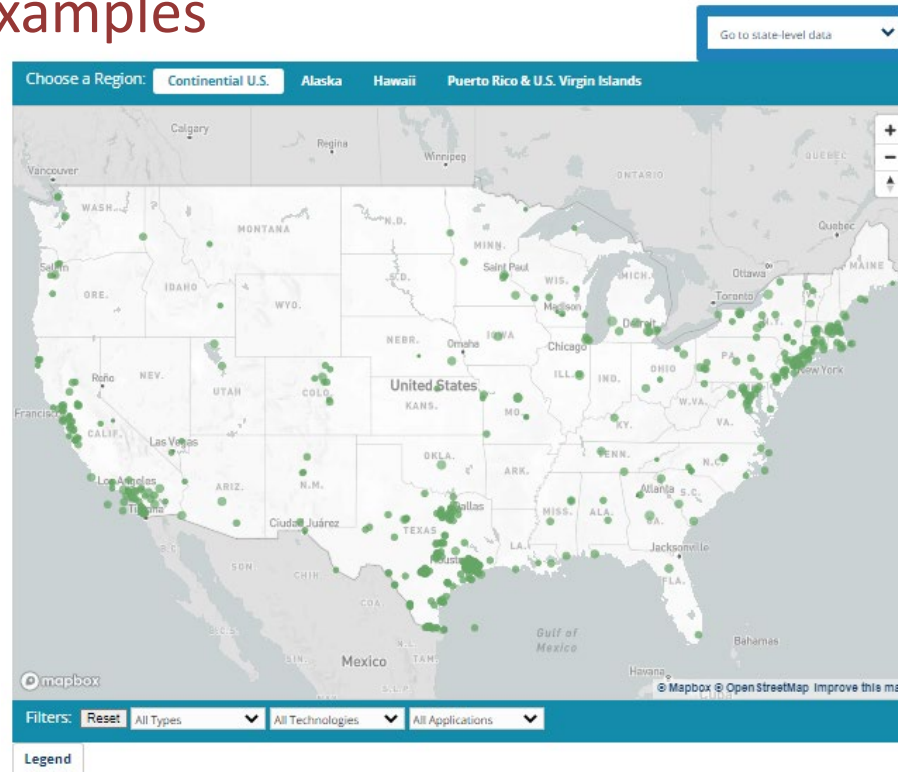
<https://www.youtube.com/watch?v=k-8AuHjEK9Y>



### 3. The Microgrid Concept.

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## Microgrid Examples



- *DoE – Database Microgrids*

— <https://doe.icfwebservices.com/microgrid>



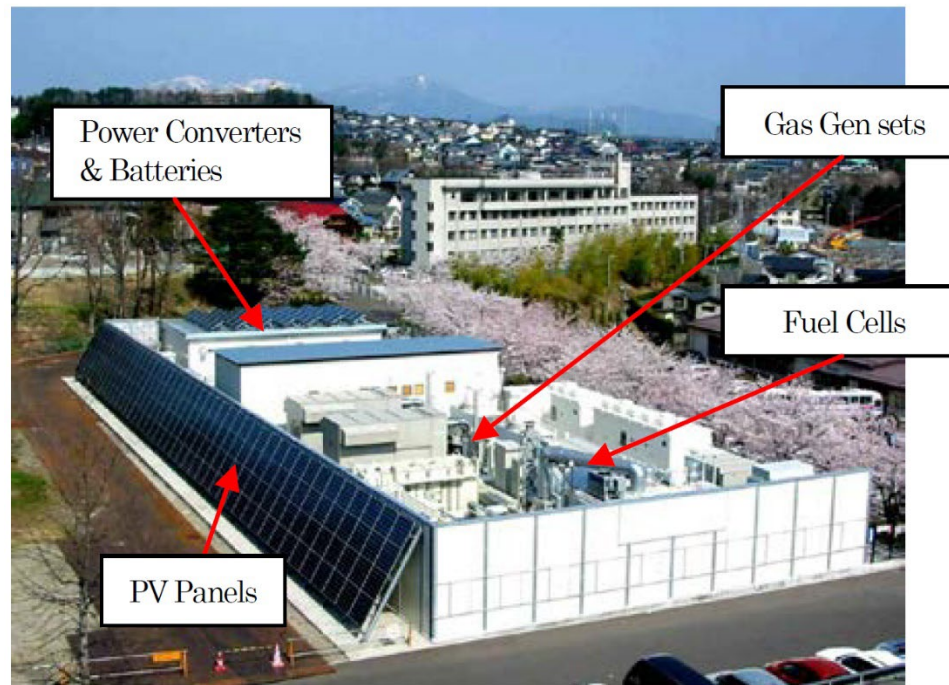


### 3. The Microgrid Concept.

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#### *Sendai Project – Japan*

- 1 MW Microgrid with sensitive loads!

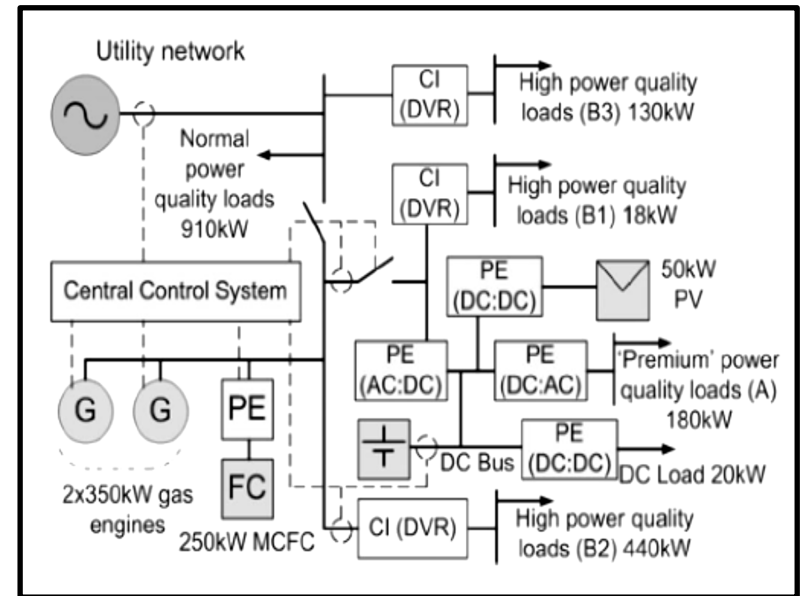
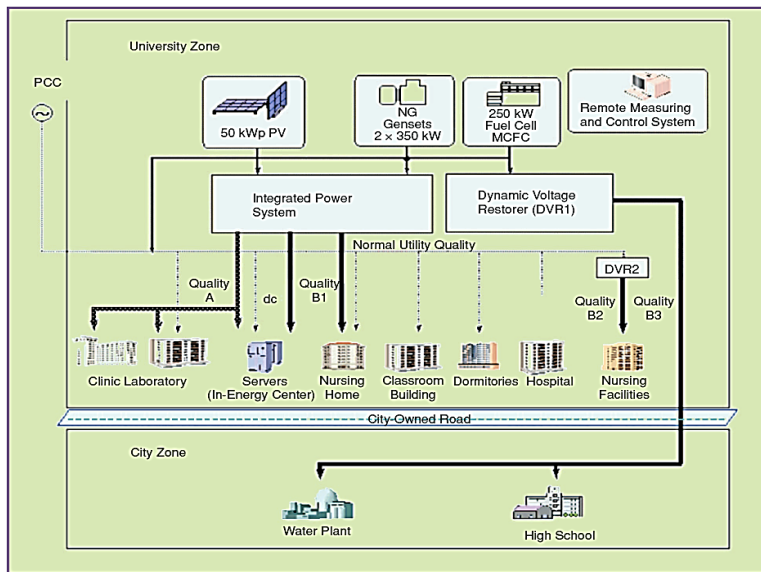




# 3. The Microgrid Concept.

## Sendai Project – Japan

- 1 MW Microgrid with sensitive loads!



# 3. The Microgrid Concept.

## Sendai Project – Japan

- 1 MW Microgrid with sensitive loads!



Sendai Minato Gas Plant



System	Mar 11	Mar 12	Mar 13	Mar 14
Utility Grid	Grid Connection	14:47 Voltage Collapse → Grid Outage	Outage	Grid Recover Grid Connection
Gas Engine	Grid Connection	Disconnect Stop	Around 12:00 Islanding operation	Grid Connection
DC supply	Grid Connection	Supply from Battery	Supply from Gas Engine	Grid Connection
A Quality	Grid Connection	02:05 Stopped Manually Battery Outage	Supply from Gas Engine	Grid Connection
B1 Quality	Grid Connection	Battery Outage	Supply from Gas Engine	Grid Connection
B3 Quality	Grid Connection	Outage	Around 14:00 Dispatch Start (because of customer's wish) Supply from Gas Engine	Grid Connection
C Quality	Grid Connection	Outage	Supply from Gas Engine	Grid Connection



# 3. The Microgrid Concept.

## USE CASES

Prosumer / Residential Areas



Remote sites, Islands and community villages



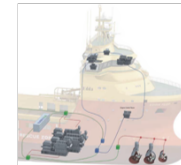
Multi-zonal commercial areas



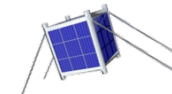
AC/DC Rural electrification



Shipboard MGs



Spatial Nanosatellite Microgrids



IoT-enabled Energy Microgrids, Energy Internet



Center of Research in Microgrids CROM

<https://www.crom.et.aau.dk/phd-industrial-projects/activities/crom/>

© Microgrid Research Programme



# 1. Hierarchical Control

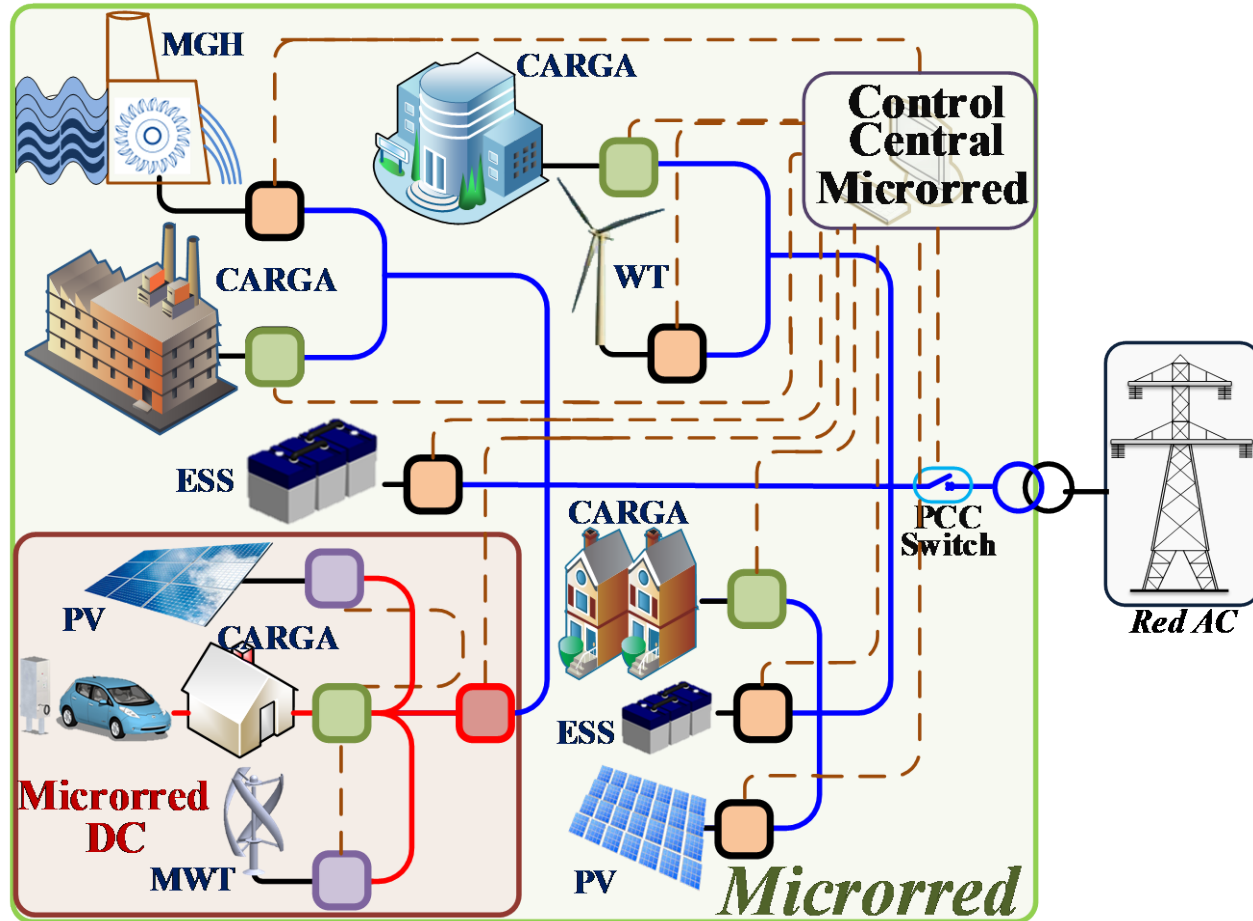
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**Colombia?**

<https://www.youtube.com/watch?v=DiGBeoTz8dM>



### 3. The Microgrid Concept.



# 4. Microgrids Based on Power Electronics Converters

